1. INTRODUCTION

1. 1. General Information

The Type 9 CCTV is a closed-circuit television system of solid-state design. The units are constructed in modular form, using standard framework and cases. The main modules can be mounted on a suitable bench or stand; alternatively, a 3- or 4- module system may be accommodated in a standard 19-inch rack. The extreme flexibility of the equipment allows for a wide range of system variants to be assembled, from a simple random interlace camera channel, to a complete C.C.I.R. standard broadcast channel with a wide range of additional accessories. Due to its modular form, it is possible, initially, to have a simple system, and add to it later to develop a more sophisticated system. Where possible, components are mounted on printed-circuit boards for ease of servicing; these boards have the component identities printed on them. Most of the preset controls are available behind the front panels of the units.

Three standards of waveform are available, viz, C.C.I.R.Standard, 2:1 Interlaced; Industrial, 2:1 Interlaced; or Random Interlaced. Three line standards are available - 405, 525 and 625; selection is effected by means of two sets of push-buttons, which are accessible from the front of the modules.

Various cameras are available, catering for many differing applications, from general industrial use to studio broadcasting. Each camera is connected to its control unit via a multi-way cable. This cable can be up to 1000 ft long; lengths of extension cable may be connected by the use of special junction boxes.

A full range of accessories can be added to the basic system to provide remote control of all the camera functions. These accessories can be divided into two groups:

(a) Electrical

These accessories provide control, from a remote position, of all of the necessary electrical functions associated with Vidicon cameras.

(b) Optical

This group provides remote control of the functions associated with the camera lens (e.g. focus, iris and zoom settings) by means of motors mounted on the camera.

1. 2. Brief Description of the Units

(a) Camera 'A'
Type BC900

The camera is contained in a cylinder which houses electrical circuits, the Vidicon tube and the focusing mechanism. Connexion to the control unit is made via a 32-way cable.

(b) Camera 'B'
Type BC910

This is a larger version of camera 'A', containing the same circuits. Provision is included for mounting certain of the accessory units in the camera. The whole assembly is contained in a rectangular-shaped case. This camera may be fitted with a two-lens turret, Connexion is made by a 32-way cable.

(b1) Type BC910VF

It is possible to modify the BC910 camera to incorporate an electronic 4 in. viewfinder monitor, talkback and cues. Two camera cables are required, one for the camera, the other for talkback, cues, power and drives for the electronic viewfiner monitor.

(b2) Type BC920

This is a camera 'A' in a modified 'B' case. It has side focus, 4-lens turret, electronic viewfinder, talkback and cues. Two cables are provided, one for camera, the other for talkback, cues, power and drives for the electronic viewfinder.

(c) Camera 'D'
Type BC930

This is a special miniature camera for viewing in confined spaces. It comprises two tubular sections, one section housing the $\frac{1}{2}$-in Vidicon tube and deflection coils, the other section housing the video amplifier and scan circuits.

Vidicon Tubes

EMI Type 9677, 1-in, high-resolution, separate mesh tube for Cameras 'A' or 'B'.

EMI Type 9697, $\frac{1}{2}$-in, high-resolution, separate mesh tube for Camera 'D'.

The spectral response at the vidicon tube is similar to that of panchromatic film. Other sensitive tubes can also be supplied. Heater supply (nominal) : 6.3V, 90mA.

(d) Sync Generator
Type SG900

This unit generates the field and line timing pulses used throughout the system. Push-button selection

(d) Sync Generator Type SG900	of 405, 525 or 625 mode of operation is provided. Pulses at twice the line frequency are also generated for use with the broadcast sync shaper.
(e) Broadcast Sync Shaper Type BSS900	This unit receives timing pulses from the sync generator, and uses them to initiate mixed blanking and mixed sync pulses (timed to C.C.I.R standards) to enable the system to be used for broadcast studio purposes. It also produces line and field drive waveforms to trigger the appropriate sawtooth oscillators in the Camera Control Unit, type CC900. Three push-buttons on the front panel permit selection of 405, 525 or 625 line standards.
(f) Studio Version Kit Type BSS901	The kit consists of three plug in cards which can be mounted inside the broadcast sync shaper. They shape the outputs of the broadcast sync shaper and allow the outputs to be terminated with an impedance of 75Ω to C.C.I.R. standards. When the kit is fitted, the type number of the broadcast sync shaper is BSS900/1.
(g) Camera Control Unit Type CC900	This unit produces scanning drive waveforms for the Vidicon tube in the camera. It also combines system sync and blanking pulses with the video signal from the camera to produce a composite waveform. A non-composite video waveform can be made available. In addition, the camera field blanking pulses are generated within this unit.
(h) Sync Unit Type CC902	This unit is a plug-in sub-assembly of the camera control unit. It is used when Industrial Standard Interlace is required and replaces the part of the broadcast sync shaper which produces the mixed sync and mixed blanking pulses. When it is fitted, the type number of the camera control unit is CC900/1.
(i) Delay Unit Type CC901	This is also a plug-in sub-assembly of the camera control unit. It is used in conjunction with the sync unit CC902 when Random Interlace is required, and replaces part of the sync generator. An internal control is provided to compensate for the delay introduced when using a long camera cable (i.e. in excess of 500ft). When both the units are fitted, the type number of the camera control unit is CC900/2.

(j) Power Unit Type PSU900	This produces all the d.c. stabilized voltages required in the system. It also produces the d.c. line and field shift voltages. Provision is also included for mounting certain accessory units. A power unit can be used with a sync pulse generator (and C.C.U.) with or without a broadcast shaping unit, to provide an independent source of sync pulses. A composite video output is available from the power unit when used with a camera.
(k) Mains Switching Unit Type RA912	This unit is housed in the power unit when the camera control panel RA908 or CC/auto light unit RA914 is not incorporated therein. It is used to switch the mains supply.
(l) Accessories Module Case Type RA905	This module is used as a method of conveniently housing the accessory units. It can accommodate two standard sub-units and one additional, non-standard sub-unit. The accessories module case is connected to the power supply unit by a 19-way cable, having a maximum length of 500 ft.
(m) Remote Control Unit Type RA901	One of the remote accessory units, providing control over the motors which drive the camera's optical system, (unit RA902, RA903, focus and iris etc).
(n) Camera Control Panel Type RA908	A remote accessory unit which provides manual control of the Vidicon's beam, target and focus potentials. It can be mounted in the power unit, camera 'B' (BC910), the accessories module case (RA905) or other remote location.
(o) Camera Control/Auto Light Unit Type RA914	Similar, in design and function, to the camera control panel (RA908) except that the target potential is automatically controlled.
NOTE: Zoom, Focus and Iris Type L2M93 (Special project item, to order)	Three motors which fit on the rear of camera 'A'. They are used in conjunction with an Angenieux type L2/L5 zoom lens to control, from a remote position, the lens settings.
(p) Focus Drive Type RA902	A remotely-controlled motor which is mounted on the rear of camera 'A' or 'B'. It is used with any lens.

(q)	Iris Drive Type RA903	A remotely-controlled motor which is mounted on the front of camera 'A' or 'B'. It is used with TV broadcast type Vidital (R.T.H.)/Vidiac (Dallmeyer) lenses.
(r)	Two lens Turret Type RA904	Kit containing a turret fixture and remotely-controlled motor. The motor rotates the turret, which will accommodate two lenses, to bring the desired lens into used.
(s)	Scan Reversal Type CM902	Kit containing a control unit and the necessary parts to modify a camera and power unit. This kit facilitates the production of an image that is reversed about the x and y axes, for use in special applications. The control unit is mounted in the accessory module case.
(t)	Pos/Neg Switching Type CM903	Kit containing a control unit, and the necessary parts to modify a camera control unit. This permits a negative picture (i.e. black-white reversal) to be displayed. The control unit is housed in the accessories module case.

Other Accessories

Exterior cover for Camera 'A' (BC900) to enclose the lens. Range of Video and Pulse Distribution, switching, fading and superimposing equipment.

Weatherproof housings with remotely-controlled windscreen wipers, heating, cooling and demisting facilities. Dustproof, acoustic and underwater housings also available.

Simple pan and tilt units are available, both for indoor and outdoor use; these can be manually or remotely controlled.

A full range of tripods is available.

A wide variety of lenses can be used: e.g. a D-mount; C-mount 16mm focusing (a special mount adaptor 7A/A5681 is required); wide angle, telephoto and zoom, (manually and remotely controlled).

Television Camera Lenses (1-in Vidicon Camera)

The lenses listed in table 1 have been specially designed for use with CCTV cameras which are operated with a one-inch vidicon tube and a picture format 0.5in by 0.375in (12.7mm by 9.5mm). 0.625in (15.9mm) diagonal. Particular attention has been given in lens design to compensate for the appreciable optical aberrations which are introduced by the glass thickness of the end-face of the vidicon tube.

The lenses must be used with CCTV cameras that are focused by the mechanical movement of the vidicon and scan coil assembly within the camera, (1.5in by 24 t.p.i. 0.507in mechanical back focal distance). A geared iris ring is also fitted to make the lenses very suitable for remote iris control. (Iris-operating geared wheel 2.698in outside diameter, PCD 2.625in, 84 teeth, 32 DP, anti-clockwise rotation of geared wheel, viewed from the front of lens, to reduce aperture - B.S.I. standard).

A special hooded mount is incorporated in all the lenses.

TABLE 1

Make	Type	Focal length in.	Focal length mm	Aperture f	Horizontal angular coverage (degrees)	Lens elements
Rank Taylor, Hobson	LTV1	0.8	20	1.7	35	9)
	LTV2	1.2	30	1.4	24	9) Anastigmat,
Vidital	LTV3	2.0	50	1.4	14	9) coated,
	LTV4	3.2	80	1.4	9	9) with hood and cap.
	LTV5	0.47	12	1.4	56	9)
Dallmeyer Vidiac	LDV1 (C2254)	0.8	20	1.9	34	6)
	LDV2 (C2253)	1.0	25	1.9	28	6) Anastigmat, coated, with hood and cap.
	LDV3 (C2255)	2.0	50	1.9	14	6)
	LDV4 (C2252)	3.0	75	1.9	9	6)

Television Camera Lenses (C-mount non-focusing)

These lenses are listed in table 2 together with a summary of their characteristics.

TABLE 2

Make	Type	Focal in.	Length mm	Aperture f	Horizontal angular coverage (degrees)	Lens elements
Dallmeyer	LDC2U	1.0	25	0.98	28	8, coated with hood and cap.
	LDC1 (C2071)	0.8	20	1.9	34	TV Super Six, anastigmat, coated, with hood and cap.
	LDC2 C1502)	1.0	25	1.9	28	
	LDC3 (C1757)	2.0	50	1.9	14	
	LDC4 (C2078)	3.0	75	1.9	9.5	
	LDC5 (C1792)	4.0	100	1.9	7	
	LDC6 (C2370)	6.0	150	1.9	5	
	LDC7 (C2571)	9.0	225	4.5	3.2	TV Telephoto, coated, with hood and cap.
	LDC8 (C1561) (C2526)	12.0	305	4.5	2.4	

Standard Cinematograph Lenses (C-mount micrometer-focusing)

These lenses are listed in table 3 together with a summary of their characteristics.

TABLE 3

Make	Type	Focal in.	Length mm	Aperture f	Horizontal angular coverage (degrees)	Lens elements
Dallmeyer	LDF2U	1.0	25	0.98	28	8, coated, with hood and cap.
	LDF1	0.6	15	1.5	44 Super Six	Anastigmat, coated, with hood and cap.
	LDF3	1.0	25	1.9	28 Cine	
	LDF4	2.0	50	1.9	14 Cine Long Focus	
	LDF5	3.0	75	1.9	9.5 Cine Long Focus	
	LDF6	3.0	75	3.5	9.5	
	LDF7	4.0	100	3.5	7 Cine Telephoto	
	LDF8	6.0	150	3.5	5 Cine Telephoto	
	LDF9	9.0	225	4.5	3.2 Cine Telephoto	
	LDF10	12.0	305	4.5	2.4 Cine Telephoto	
	LDF05	0.5	12	1.3	56	8, coated, with hood and cap.
	Cosmicar 211	1.0	25	1.9	28	8, coated with lens cap.

2. SYSTEMS

2. 1. General Information

The many assembly variants possible with the Type 9 CCTV system are shown in the schematic diagram, Fig.18. The interconnexion diagrams for cameras A, B and D, Figs.10, 20 and 21 respectively, indicate the routeing of the various functions and where they originate.

A list of units which can be employed in a system, together with their abbreviations and type numbers is given below:

Power Unit (PU) Type PSU900.

Camera Control Unit (CCU) Type CC900.

Broadcast Sync Shaper (BSS) Type BSS900.

Sync Generator (SG) Type SG900.

Camera Control Panel (CCP) Type RA908.

Remote Control Unit (RCU) Type RA901.

Camera Control/Auto Light Unit (CC AUTO) Type RA914.

Mains Switching Unit (MSU) Type RA912.

Scan Reversal (SR) Type CM902.

Pos/Neg Switching (P/NS) Type CM903.

Delay Unit (DV) Type CC901.

Sync Unit (SU) Type CC902.

Accessories Module Case (AMC) Type RA905.

2. 2. Basic Channel

The basic camera channel consists of a camera, its connecting cable, a power unit, a camera control unit and (optionally) a pulse generator.

The pulse generator consists of one unit or a combination of units, depending on the system operation required.

Three standards are available with the Type 9 CCTV systems; these are detailed below, together with the units required to produce the particular standard.

(a) C.C.I.R. Standard

The waveforms produced to this standard are accurately timed and controlled by a master oscillator situated in the Sync Generator, Type SG900. Precision interlacing (2:1) is the main characteristic. The units required are:

Power Unit, Type PSU900; Sync Generator, Type SG900; Broadcast Sync Shaper, Type BSS900; Camera Control Unit Type CC900. A Mains Switching Unit, Type RA912, a Camera Control Panel, Type RA908 or a Camera Control/Auto light Unit, Type RA914 is required in the space provided within the Power Unit PSU900 module case.

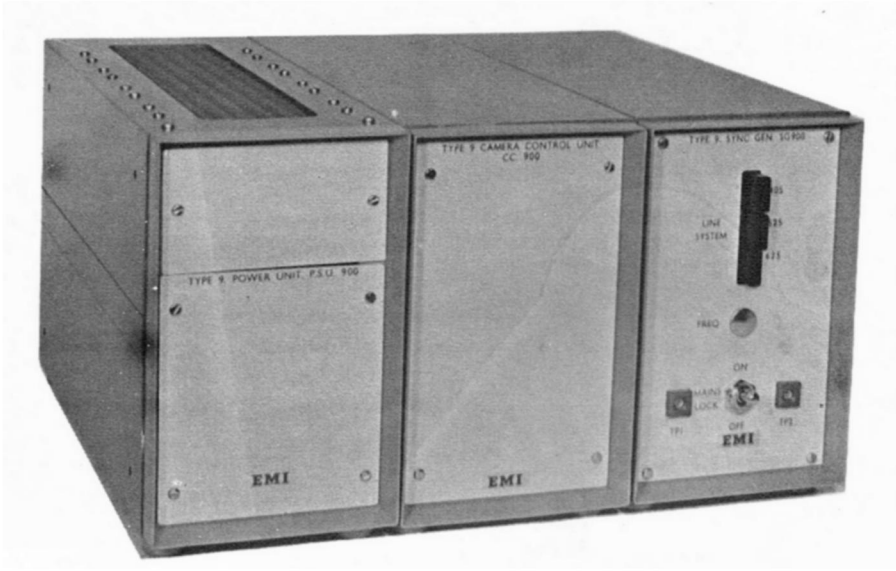
C.C.I.R. STANDARD ASSEMBLY FIG.1

(b) Industrial Standard

In this system, a plug-in sub-unit (the Sync Unit, Type CC902) is added to the camera control unit. This unit replaces parts of the broadcast sync shaper. The resultant picture is of high quality and resolution, provides industrial 2:1 interlace, but operates with a simplified field sync pulse in the synchronizing waveform.

The units required are:

Power Unit, Type PSU900; Sync Generator, Type SG900; Camera Control Unit, Type CC900; Sync Unit, Type CC902. Choice of MSU, CCP or CC AUTO positioned above the Power Unit.



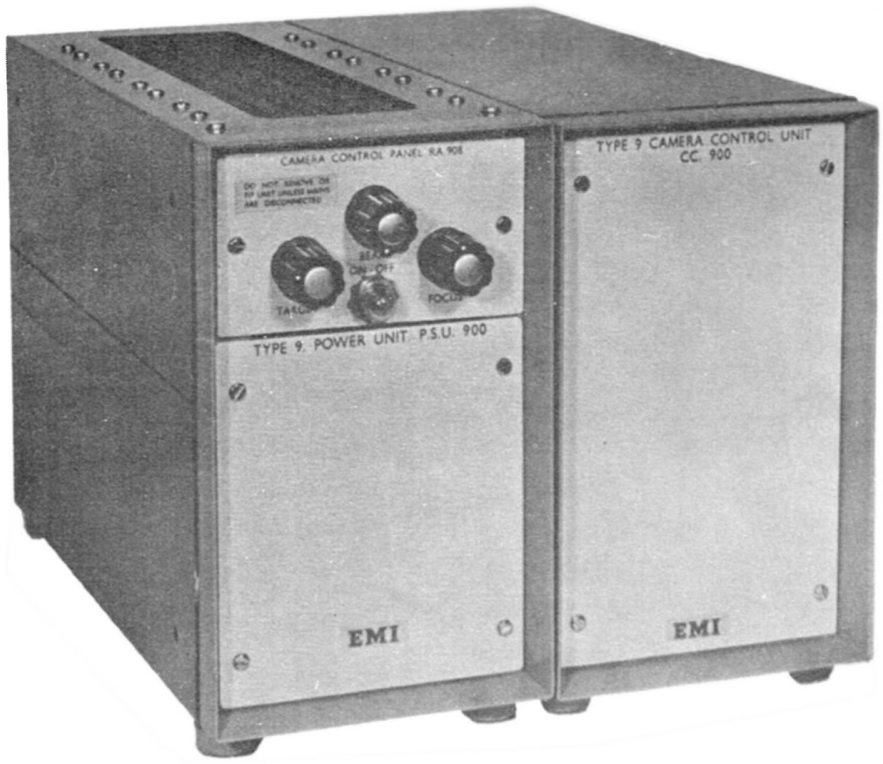
INDUSTRIAL STANDARD ASSEMBLY FIG.2

NOTE:
When the sync unit is mounted in the camera control unit CC900, the whole assembly has a new type number - CC900/1.

(c) Random Interlace

When Random Interlace is required, a Delay Unit Type CC901, together with the sync unit, is added to the camera control unit. The delay unit replaces parts of the sync generator. The picture obtained is still of reasonable quality, but with degraded vertical resolution, possibly making it unsuitable for certain applications (e.g. document observation). The units involved are:

Power Unit, Type PSU900; Camera Control Unit, Type CC900; Sync Unit, Type CC902; Delay Unit, Type CC901.

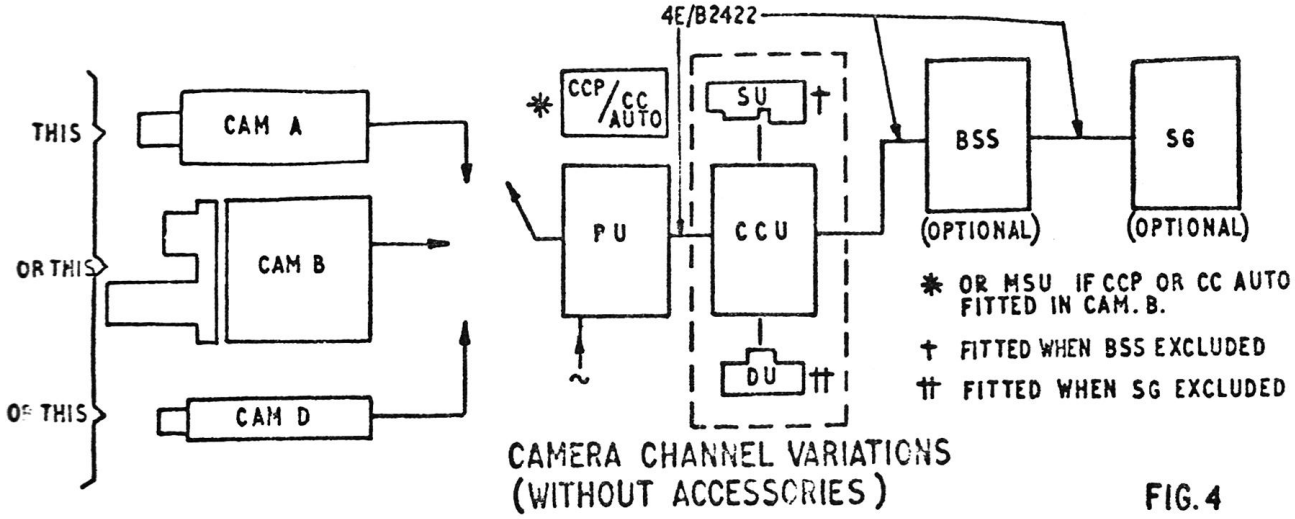


RANDOM INTERLACE ASSEMBLY FIG.3

NOTE:

With both sub-units plugged in, the part number of the camera control unit is CC900/2.

Thus, a camera channel having no accessories has the form shown in Fig.4.



CAMERA CHANNEL VARIATIONS
(WITHOUT ACCESSORIES)

FIG. 4

2. 3. Accessories

Various electrical and optical accessories are available; these, when used in combination, permit control of many of the camera functions from a remote position. This allows the camera to be installed in confined spaces.

3. SPECIFICATION

3. 1. Camera Channel

Line Standard	Three standards are available - 405 (50Hz), 525 (60Hz), and 625 (50Hz). Selection is by a push-button system located at the front panels of the SG900 and BSS900
Interlace	Random or interlaced 2 to 1.
Linearity and Geometry	Combined error not greater than 2% of picture height and width.

Cameras 'A' and 'B'

Bandwidth	8MHz ± 3dB.
Resolution	Not less than 650 lines at picture centre; not less than 400 lines at corners (when using a TTH vidital lens).
Sensitivity	With a scene illumination of 2 ft candles (20 lux), with 50% subject reflection, lens aperture at f/2, and using an EMI 9677 Vidicon, a fully contrasted picture is obtained.

Camera 'D'

Handwidth	5MHz ± 3dB with 6 in (15cm) separation between camera head units.
Resolution	Not less than 400 lines in the useful picture area.
Sensitivity	With a scene illumination of 4ft candles (40 lux), with 50% subject reflection, lens aperture at f/2, and using an EMI 9697 Vidicon, a fully contrasted picture is obtained.
Vidicon Tube	1-inch EMI High-Resolution Separate-Mesh Tube Type 9677 (for cameras 'A' and 'B') or $\frac{1}{2}$-inch EMI High-Resolution Separate-Mesh Tube Type 9677 (for camera 'D').

Spectral Response	The response of the Vidcon tube is similar to that of panchromatic film. Tubes with special spectral response are available to order.
Aperture Compensation	Switchable 405, 525/625 lines.
Power Supplies	100 to 120V a.c. or 200 to 250V a.c., 50 or 60Hz. Consumption 15 to 30VA.
Finish	Two tone, green and grey.
Ambient Temperature Range	-5° to $+50^{\circ}$C.

3. 2. Sync Outputs using Broadcast Sync Shaper

NOTE: The figures in brackets are those obtained on 525 or 625 line systems; the others are for 405 lines.

OUTPUTS

Mixed Blanking

Line Blanking

Polarity	Negative-going.
Amplitude	6V (measured from 0V) .
Rise time	0.25µs .
Duration	18 ± 1µs (12 ± 1µs) .

Field Blanking

Polarity	Negative-going.
Amplitude	6V (measured from 0V).
Rise time	0.25µs.
Duration	800 to 1800µs, variable.

Mixed Sycn

Line Sync

Polarity	Negative-going .
Amplitude	6V or 10V (measured from 0V).
Rise time	0.15µs.
Duration	9 ± 1µs (5 ± 1µs).

Field Sync

Polarity	Negative-going.
Amplitude	6V or 10V (measured from 0V).
Rise time	0.15µs.
Duration	9 ± 1µs (5 ± 1µs) between broad pulses.

Equalizing Pulses (525/625 line only)

Polarity	Negative-going.
Amplitude	6V or 10V (measured from 0V).
Rise time	0.15µs.
Duration	2.5 ± 0.5µs.

Line Drive

Polarity	Negative-going.
Amplitude	6V or 10V (measured from 0V).
Rise time	0.15µs.
Duration	6.5µs.

Field Drive

Polarity	Negative-going.
Amplitude	6V or 10V (measured from 0V).
Rise time	0.15µs.
Duration	7 ($9\frac{1}{2}$) lines.